

**CLAIMS:**

1. A method for derivatizing sidewalls of carbon nanotubes comprising:
  - (a) selecting a plurality of carbon nanotubes; and
  - (b) reacting the plurality of carbon nanotubes with a diazonium specie.
- 5 2. A method comprising:
  - (a) selecting a plurality of carbon nanotubes;
  - (b) reacting the plurality of carbon nanotubes with a diazonium specie to form derivatized carbon nanotubes;
  - (c) dispersing the derivatized carbon nanotubes in a solvent.
- 10 3. A method for derivatizing single-wall carbon nanotubes comprising:
  - (a) selecting an assembly of single-wall carbon nanotubes;
  - (b) immersing the assembly in a solution comprising a diazonium specie; and
  - (c) applying a potential to the assembly to electrochemically react the assembly with the diazonium specie.
- 15 4. A method for derivatizing single-wall carbon nanotubes comprising:
  - (a) selecting a plurality of single-wall carbon nanotubes;
  - (b) preforming a diazonium specie; and
  - (c) reacting the plurality of single-wall carbon nanotubes with the preformed diazonium specie.
- 20 5. A method for derivatizing single-wall carbon nanotubes comprising:
  - (a) selecting a plurality of single-wall carbon nanotubes;
  - (b) mixing a precursor of a diazonium specie with the plurality of single-wall carbon nanotubes;
  - (c) generating the diazonium specie; and
  - (d) reacting the plurality of single-wall carbon nanotubes with the diazonium specie.
- 25 6. The method of claims 1 or 2, wherein the plurality of carbon nanotubes comprise single-wall carbon nanotubes.
7. The method of claims 3, 4, 5, or 6, wherein the single-wall carbon nanotubes have an average diameter of at most about 0.7 nm.
- 30 8. The method of claims 1, 2, or 4, wherein the plurality are electrochemically reacted with the diazonium specie.
9. The method of claims 1 or 2, wherein the plurality are thermally reacted with the diazonium specie.
10. The method of claims 5 or 9, wherein the diazonium specie is generated *in situ*.
- 35 11. The method of claims 1 or 2, wherein the diazonium specie is preformed before the plurality are thermally reacted with the diazonium specie.
12. The method of claims 1, 2, or 4, wherein the plurality are photochemically reacted with the diazonium specie.

13. The method of claims 1, 2, 3, 4, or 5, wherein the diazonium specie comprises an aryl diazonium specie.
14. The method of claims 1, 2, 3, 4, or 5, wherein the diazonium specie comprises a species selected from the group consisting of an alkyl diazonium specie; an alkenyl diazonium specie; an alkynyl diazonium specie, and combinations thereof.
- 5 15. The method of claims 1, 2, 4, or 5, wherein the plurality is an assembly of carbon nanotubes.
16. The method of claim 1, 2, 3, 4, or 5 wherein the assembly is selected from the group consisting of a bucky paper and a mat.
- 10 17. The method of claims 1, 2, or 4 further comprising:
- (a) immersing the assembly in a solution comprising the diazonium specie; and
  - (b) applying a potential to the assembly.
18. The method of claims 3 or 17, wherein the potential is a negative potential.
19. The method of claims 3 or 17, wherein the solution further comprises a supporting electrolyte specie.
- 15 20. The method of claims 1, 2, 3, 4, 17, or 18, wherein the step of applying a potential to the assembly comprises holding the assembly with an alligator clip treated with a colloidal silver paste.
21. The method of claims 1, 2, 3, 4, or 5, wherein the diazonium specie comprises a diazonium salt.
- 20 22. The method of claim 21, wherein the diazonium salt comprises a salt selected from the group consisting of an aryl diazonium salt, an alkyl diazonium salt, an alkenyl diazonium salt, an alkynyl diazonium salt, and combinations thereof.
23. The method of claims 1, 2, 3, 4, or 5 further comprising sonicating the derivatized carbon nanotubes.
- 25 24. The method of claims 1, 2, 3, 4, or 5, wherein the amount of a moiety bonded to the carbon atoms of a carbon nanotube is at a moiety to carbon ratio at least about one moiety to forty carbon atoms.
- 25 25. The method of claims 1, 2, 3, 4, or 5, wherein the amount of a moiety bonded to the carbon atoms of a carbon nanotube is at a moiety to carbon ratio at least about one moiety to thirty carbon atoms.
- 30 26. The method of claims 1, 2, 4, or 5, wherein the reaction is a thermal reaction at a temperature of at most about 200°C.
27. The method of claims 1, 2, 4, or 5, wherein the reaction is a thermal reaction at a temperature of at most about 60 °C.
- 30 28. The method of claims 1, 2, 3, 4, or 5 further comprising removing functional moieties from the derivatized carbon nanotubes.
- 35 29. The method of claim 28, wherein the removal step comprises heating the derivatized carbon nanotubes.
30. The method of claim 29, wherein the derivatized carbon nanotubes are heated to a temperature at least about 250°C.

31. The method of claim 29, wherein the derivatized carbon nanotubes are heated to a temperature at least about 600°C.
32. The method of claims 1, 2, or 4 further comprising photochemically reacting the plurality of single-wall carbon nanotubes and the diazonium specie.
- 5 33. The method of claim 32, wherein the photochemical reaction comprises the use of an ultraviolet light source.
34. The method of claim 32, wherein the photochemical reaction comprises the use of a visible light source.
35. The method of claim 5, wherein the precursor of diazonium specie is an aniline derivative precursor of the diazonium specie and the diazonium specie is generated with a nitrite.
- 10 36. A product made by the process comprising:
- (a) selecting a plurality of carbon nanotubes; and
  - (b) reacting the plurality of carbon nanotubes with a diazonium specie.
37. A product made by the process comprising:
- 15 (a) selecting a plurality of carbon nanotubes;
- (b) reacting the plurality of carbon nanotubes with a diazonium specie to form derivatized carbon nanotubes;
  - (c) dispersing the derivatized carbon nanotubes in a solvent.
38. A product made by the process comprising:
- 20 (a) selecting an assembly of single-wall carbon nanotubes;
- (b) immersing the assembly in a solution comprising a diazonium specie; and
  - (c) applying a potential to the assembly to electrochemically react the assembly with the diazonium specie.
39. A product made by the process comprising:
- 25 (a) selecting a plurality of single-wall carbon nanotubes;
- (b) preforming a diazonium specie; and
  - (c) reacting the plurality of single-wall carbon nanotubes with the preformed diazonium specie.
40. A product made by the process comprising:
- 30 (a) selecting a plurality of single-wall carbon nanotubes;
- (b) mixing a precursor of a diazonium specie with the plurality of single-wall carbon nanotubes;
  - (c) generating the diazonium specie; and
  - (d) reacting the plurality of single-wall carbon nanotubes with the diazonium specie.
- 35 41. The product of claims 36 or 37; wherein the plurality of carbon nanotubes comprise single-wall carbon nanotubes.
42. The product of claims 38, 39, 40, or 41, wherein the single-wall carbon nanotubes have an average diameter of at most about 0.7 nm.

43. The product of claims 36, 37, or 39 wherein the plurality are electrochemically reacted with the diazonium specie.
44. The product of claims 36 or 37, wherein the plurality are thermally reacted with the diazonium specie.
- 5 45. The product of claims 40 or 44, wherein the diazonium specie is generated *in situ*.
46. The product of claims 36 or 37, wherein the diazonium specie is preformed before the plurality are thermally reacted with the diazonium specie.
47. The product of claims 36, 37, or 39 wherein the plurality are photochemically reacted with the diazonium specie.
- 10 48. The product of claims 36, 37, 38, 39, or 40, wherein the diazonium specie comprises an aryl diazonium specie.
49. The product of claims 36, 37, 38, 39, or 40, wherein the diazonium specie comprises a species selected from the group consisting of an alkyl diazonium specie, an alkenyl diazonium specie, an alkynyl diazonium specie, and combinations thereof.
- 15 50. The product of claims 36, 37, 39, or 40, wherein the plurality is an assembly of carbon nanotubes.
51. The product of claim 36, 37, 38, 39, or 40, wherein the assembly is selected from the group consisting of a bucky paper and a mat.
52. The product of claims 36, 37, or 39 further made by the process comprising:
- 20 (a) immersing the assembly in a solution comprising the diazonium specie; and  
(b) applying a potential to the assembly.
53. The product of claims 38 or 52, wherein the potential is a negative potential.
54. The method of claims 38 or 52, wherein the solution further comprises a supporting electrolyte specie.
- 25 55. The product of claims 36, 37, 38, 39, 52 or 53, wherein the step of applying a potential to the assembly comprises holding the assembly with an alligator clip treated with a colloidal silver paste.
56. The product of claims 36, 37, 38, 39, or 40, wherein the diazonium specie comprises a diazonium salt.
57. The product of claim 56, wherein the diazonium salt comprises a salt selected from the group consisting of an aryl diazonium salt, an alkyl diazonium salt, an alkenyl diazonium salt, an alkynyl diazonium salt, and combinations thereof.
- 30 58. The product of claims 36, 37, 38, 39, or 40, further made by the process comprising sonicating the derivatized carbon nanotubes.
59. The product of claims 36, 37, 38, 39, or 40, wherein the amount of a moiety bonded to the carbon atoms of a carbon nanotube is at a moiety-to-carbon ratio at least about one moiety to forty carbon atoms.
- 35 60. The product of claims 36, 37, 38, 39, or 40, wherein the amount of a moiety bonded to the carbon atoms of a carbon nanotube is at a moiety-to-carbon ratio at least about one moiety to thirty carbon atoms.

61. The product of claims 36, 37, 39, or 40, wherein the reaction is a thermal reaction at a temperature of at most about 200°C.
62. The method of claims 36, 37, 39, or 40, wherein the reaction is a thermal reaction at a temperature of at most about 60°C.
63. The product of claims 36, 37, 38, 39, or 40 further comprising removing functional moieties from the derivatized carbon nanotubes.
64. The product of claims 36, 37, or 39 further comprising photochemically treating the mixture of the plurality of single-wall carbon nanotubes and the diazonium specie.
65. The product of claim 64, wherein the photochemical treatment comprises the use of an ultraviolet light source.
66. The product of claim 64, wherein the photochemical treatment comprises the use of a visible light source.
67. The product of claim 40, wherein the precursor of the diazonium specie is an aniline derivative precursor of the diazonium specie and the diazonium specie is generated with a nitrite.
68. A solution of single-wall carbon nanotubes made by the process of:  
(a) a plurality of derivatized single-wall carbon nanotubes, wherein the plurality of derivatized carbon nanotubes were derivatized utilizing a diazonium specie;  
(b) a solvent, wherein the derivatized plurality of carbon nanotubes are dispersed in the solvent.
69. A process comprising:  
(a) derivatizing a carbon nanotube with a diazonium specie; and  
(b) covalently attaching a molecular wire to the derivatized carbon nanotube.
70. A process comprising:  
(a) derivatizing a carbon nanotube with a diazonium specie; and  
(b) covalently attaching a molecular switch to the derivatized carbon nanotube.
71. The process of claims 69 or 70, wherein the carbon nanotube is a single-wall carbon nanotube.
72. The process of claims 69 or 71 further comprising connecting a molecular electronic device to the molecular wire.
73. The process of claims 69, 71, or 72, wherein the molecular wire comprises an oligo(phenylene ethynylene) molecular wire.
74. A product comprising:  
(a) derivatized carbon nanotube; and  
(b) a molecular wire covalently attaching to the derivatized carbon nanotube.
75. A product comprising:  
(a) derivatized carbon nanotube; and  
(b) a molecular switch covalently attaching to the derivatized carbon nanotube.
76. The product of claims 74 or 75, wherein the carbon nanotube is a single-wall carbon nanotube.

77. The product of claims 74 or 76 further comprising a molecular electronic device connected to the molecular wire.
78. The product of claims 74, 76, or 77, wherein the molecular wire comprises an oligo(phenylene ethynylene) molecular wire.
79. A method for derivatizing carbon nanotubes comprising:
- preparing an assembly, wherein:
    - the assembly comprises a first plurality of carbon nanotubes and a second plurality of carbon nanotubes; and
    - wherein the carbon nanotubes in the first plurality and the carbon nanotubes in the second plurality can be individually addressed electronically;
  - immersing the assembly in a diazonium specie; and
  - applying a negative potential to the assembly to cause the first plurality to essentially come in contact with the second plurality; and
  - electrochemically reacting the assembly with the diazonium specie.
80. A method for derivatizing carbon nanotubes comprising:
- preparing an assembly of carbon nanotubes
  - immersing the assembly in a first diazonium specie;
  - applying a potential to the assembly in a first direction;
  - electrochemically reacting the assembly with the first diazonium specie;
  - immersing the assembly in a second diazonium specie;
  - applying a potential to the assembly in a second direction; and
  - electrochemically reacting the assembly with the second diazonium specie.
81. The method of claims 79 or 80, wherein the carbon nanotubes of the first plurality comprise single-wall carbon nanotubes and the carbon nanotubes of the second plurality comprise single-wall carbon nanotubes.
82. The method of claims 79, 80, or 81, wherein the assembly is a crossbar architecture of carbon nanotubes.
83. The method of claims 79, 80, 81, or 82, wherein the preparation of the assembly comprises fluid flow over a patterned surface.
84. The method of claims 79, 80, 81, or 82, wherein the preparation of the assembly comprises direct carbon nanotube growth between posts.
85. The method of claims 79, 80, 81, or 82, further comprising connecting functionalized molecules to the assembly.
86. The method of claim 85, wherein the functionalized molecules comprise molecules that function in a capacity selected from the group consisting of molecular switches and molecular wires.
87. The method of claims 79, 80, 81, or 82, further comprising operatively connecting molecular electronic devices to the assembly.
88. A product made by the process comprising:
- preparing an assembly, wherein

- (i) the assembly comprises a first plurality of carbon nanotubes and a second plurality of carbon nanotubes; and

(ii) wherein the carbon nanotubes in the first plurality and the carbon nanotubes in the second plurality can be individually addressed electronically;

(b) immersing the assembly in a diazonium specie; and

(c) applying a negative potential to the assembly to cause the first plurality to essentially come in contact with the second plurality; and

(d) electrochemically reacting the assembly with the diazonium specie.

89. A product made by the process comprising:

  - (a) preparing an assembly of carbon nanotubes
  - (b) immersing the assembly in a first diazonium specie;
  - (c) applying a potential to the assembly in a first direction;
  - (d) electrochemically reacting the assembly with the first diazonium specie;
  - (e) immersing the assembly in a second diazonium specie;
  - (f) applying a potential to the assembly in a second direction; and
  - (g) electrochemically reacting the assembly with the second diazonium specie.

90. The product of claims 88 or 89, wherein the carbon nanotubes of the first plurality comprise single-wall carbon nanotubes and the carbon nanotubes of the second plurality comprise single-wall carbon nanotubes.

91. The product of claims 88, 89, or 90, wherein the assembly is a crossbar architecture of carbon nanotubes.

92. The product of claims 88, 89, 90, or 91, wherein the preparation of the assembly comprises fluid flow over a patterned surface.

93. The product of claims 88, 89, 90, or 91, wherein the preparation of the assembly comprises direct carbon nanotube growth between posts.

94. The product of claims 88, 89, 90, or 91, wherein the process further comprises connecting functionalized molecules to the assembly.

95. The product of claim 94, wherein the functionalized molecules comprise molecules that function in a capacity selected from the group consisting of molecular switches and molecular wires.

96. The product of claims 88, 89, 90, or 91, wherein the process further comprises operatively connecting molecular electronic devices to the assembly.

97. A method for making a polymer material comprising:

  - (a) derivatizing carbon nanotubes with functional moieties to form derivatized carbon nanotubes, wherein the functional moieties are derivatized to the carbon nanotubes utilizing a diazonium specie;
  - (b) dispersing the derivatized carbon nanotubes in a polymer.

98. The method of claim 97, wherein the carbon nanotubes are single-wall carbon nanotubes.

99. The method of claims 97 or 98, wherein the functional moieties are chemically bound to the polymer.

100. The method of claims 97 or 98, wherein the functional moieties are not chemically bound to the polymer.
101. The method of claims 97 or 98, wherein the functional moieties are removed after the dispersing step.
- 5 102. The method of claim 101, wherein the removal step comprises heating the dispersal of the derivatized carbon nanotubes and the polymer to a temperature at least about 250°C.
103. The method of claim 101, wherein the removal step comprises heating the dispersal of the derivatized carbon nanotubes and the polymer to a temperature at least about 600°C.
104. The method of claims 97 or 98, wherein the functional moiety is operable to react with a curing agent.
- 10 105. The method of claims 104, wherein the polymer comprises the curing agent.
106. The method of claim 104, wherein the curing agent is dispersed in the dispersal of the derivatized carbon nanotubes and the polymer.
107. The method of claims 104, 105, or 106, wherein the curing agent comprises an agent selected from the group consisting of diamines, polymercaptans, and phenol containing materials.
- 15 108. The method of claims 97 or 98, wherein the functional moiety is operable to react with a epoxy portion.
109. The method of claims 108, wherein the polymer comprises the epoxy portion.
110. The method of claims 104, 105, 106, 107, 108, or 109 further comprising curing the dispersal of the derivatized carbon nanotubes and the polymer.
- 20 111. A polymer material comprising:
- (a) derivatized carbon nanotubes, wherein the derivatized carbon nanotubes comprise a diazonium species moiety; and
- (b) a polymer, wherein the derivatized carbon nanotubes are dispersed in the polymer.
- 25 112. A polymer material comprising:
- (a) derivatized carbon nanotubes, wherein the derivatized carbon nanotubes were derivatized utilizing a diazonium species; and
- (b) a polymer, wherein the derivatized carbon nanotubes are dispersed in the polymer.
- 30 113. A polymer material made by the process comprising:
- (a) derivatizing carbon nanotubes with functional moieties to form derivatized carbon nanotubes, wherein the functional moieties are derivatized to the carbon nanotubes utilizing a diazonium species;
- (b) dispersing the derivatized carbon nanotubes in a polymer.
- 35 114. The polymer material of claims 111, 112, or 113, wherein the carbon nanotubes are single-wall carbon nanotubes.
115. The polymer material of claims 111, 112, 113, or 114, wherein the functional moieties are chemically bound to the polymer.
116. The polymer material of claims 111, 112, 113, or 114, wherein the functional moieties are not chemically bound to the polymer.

117. The polymer material of claims 111, 112, 113, or 114, wherein the functional moiety is operable to react with a curing agent.

118. The polymer material of claims 117, wherein the polymer comprises the curing agent.

119. The polymer material of claim 117, wherein the curing agent is dispersed in the dispersal of the derivatized carbon nanotubes and the polymer.

120. The polymer material of claims 117, 118, or 119, wherein the curing agent comprises an agent selected from the group consisting of diamines, polymercaptans, and phenol containing materials.

121. The polymer material of claims 111, 112, 113, or 114, wherein the functional moiety is operable to react with a epoxy portion.

122. The polymer material of claims 121, wherein the polymer comprises the epoxy portion.

123. The polymer material of claims 117, 118, 119, 120, 121, or 122, wherein the process further comprises curing the dispersal of the derivatized carbon nanotubes and the polymer.

124. A method for making a polymer material comprising:

(a) derivatizing carbon nanotubes with functional groups to form derivatized carbon nanotubes, wherein:

- (i) the functional groups are derivatized to the carbon nanotubes utilizing a diazonium specie and
- (ii) the functional groups are capable of polymerizing; and

(b) polymerizing the derivatized carbon nanotubes to grow polymer from the functional groups.

125. The method of claim 124, wherein the carbon nanotubes are single-wall carbon nanotubes.

126. The method of claims 124 or 125, wherein the polymerization step comprises a technique selected from the group consisting of radical, cationic, anionic, condensation, ring-opening, methathesis, and ring-opening-metathesis (ROMP) polymerizations.

127. A polymer material made by the process comprising:

(a) derivatizing carbon nanotubes with functional groups to form derivatized carbon nanotubes, wherein:

- (i) the functional groups are derivatized to the carbon nanotubes utilizing a diazonium specie and
- (ii) the functional groups are capable of polymerizing; and

(b) polymerizing the derivatized carbon nanotubes to grow polymer from the functional groups.

128. The polymer material of claim 127, wherein the carbon nanotubes are single-wall carbon nanotubes.

129. The polymer material of claims 127 or 128, wherein the polymerization step comprises a technique selected from the group consisting of radical, cationic, anionic, condensation, ring-opening, methathesis, and ring-opening-metathesis (ROMP) polymerizations.